GUIDE BOOK

FIELD TRIP

Forty-second Annual Meeting
American Association of Petroleum Geologists

by
Robert D. Knight and John W. Koenig

St. Louis, Missouri
April 5, 1957

STATE OF MISSOURI
Department of Business and Administration

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THOMAS R. BEVERIDGE, State Geologist
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John W. Koenig	Missouri Geological Survey
Garrett A Muilenburg	Missouri Geological Survey
Kenneth G. Brill, Jr.	St. Louis University
Earl McCracken	Missouri Geological Survey
Ernest L. Ohle	St. Joseph Lead Company
Robert D. Knight	Missouri Geological Survey

INTRODUCTION

The purpose of this field conference is to exhibit and discuss as much of the Paleozoic section in the St. Louis area as can be conveniently seen in one day. The field trip should be of interest to petroleum geologists because the equivalents of many of the subsurface oil bearing rocks in West Texas, New Mexico, Oklahoma, and Kansas are exposed in this area (Fig. 1). Although there may be many questions concerning interstate correlation of these units, the members of the Subsurface Division of the Missouri Geological Survey have found that a study of the contained insoluble residues is indespensible for state-wide problems, and they believe that similar studies would be very useful for long range correlation. Within the State of Missouri all identifications and correlations of pre-St. Peter rocks in the subsurface are based on residue studies.

The study of insoluble residues had its inception in 1924. At that time, H. S. McQueen was engaged in a structural mapping problem in an area underlain by dolomite and dolomitic limestones of the Jefferson City and Cotter formations. During the course of a field conference, H. A. Buehler, then the Director of the Missouri Survey, suggested that certain sections be measured in detail and samples taken from the different beds of dolomite for the purpose of studying the original rock and the insoluble residues obtained by digesting the dolomite in hydrochloric acid. In the laboratory, certain differences were noted in the residues, and these checked with the field observations. A short time later, residues were made on drill samples from a deep well in southeast Missouri. An examination of them proved to be very helpful in the correlation of the formations penetrated, and also enabled the Survey to advise definitely in regard to several problems connected with this drilling (McQueen, 1931, p. 103). Since then the Survey has processed, examined, and recorded the cuttings of nearly 16,000 drill holes, which represents more than one million samples.

ACKNOWLEDGMENTS

The Chairman of the Field Trip Committee and the authors of the guidebook are indebted to the following individuals for their generous assistance. Dr. Norman S. Hinchey of Washington University as a member of the Committee assisted in the preparation of the Mississippian sections. Dr. Kenneth G. Brill of St. Louis University and Dr. Garrett A Muilenburg of the Missouri Geological Survey aided in the stratigraphic study of the Middle Ordovician section at Stop 2. Dr. Alfred C. Spreng of the University of Missouri School of Mines identified the megafauna from the Warsaw limestone at Stop 1. Dr. William C. Hayes, Mr. James Martin, and Mr. Henry Groves of the Missouri Geological Survey assisted the senior author in measuring several of the sections, and Henry Groves prepared all the photographs. Other staff members of the Missouri Geological Survey who have contributed much to the compilation of this guidebook also deserve recognition, namely: Mr. John G. Grohskopf and Mr. Earl McCracken for their experienced comments and suggestions, Mr. E.H. Woolrych and Mr. H.M. Werbitzky, Jr. for drafting the stratigraphic sections, and Miss Bonnie L. Wills for typing the manuscript.

The success of the field trip is to be credited to the able efforts of the general Chairman of the Central Committee, Harold T. Morley of the Stanolind Oil and Gas Company and the Transportation Director, Thomas E. Neudecker of W.C. McBride, Inc.

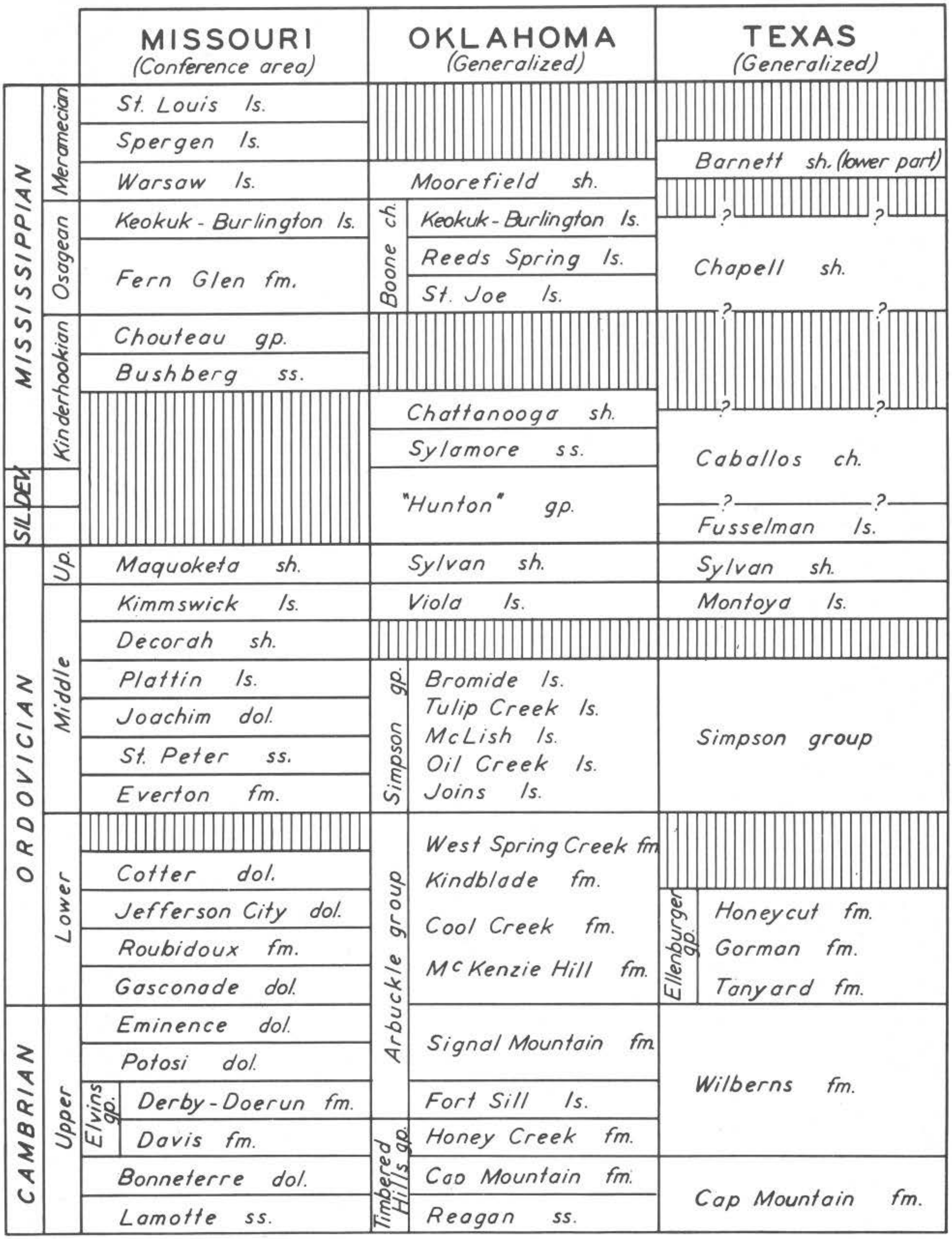


Fig. 1
Generalized Correlation Chart

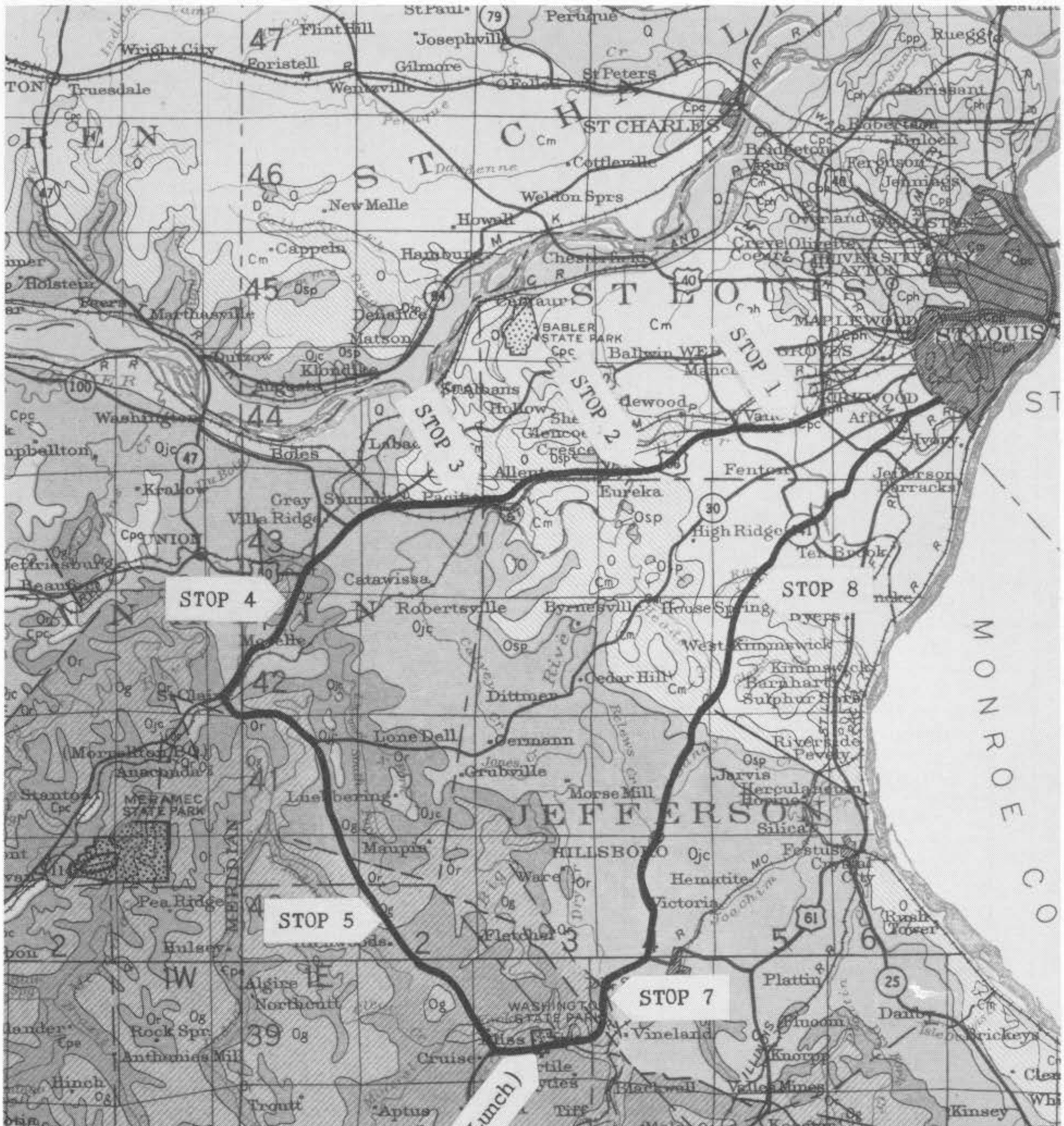


Fig. 2
Route Map

ST. LOUIS AREA

The field trip busses will depart from downtown St. Louis, but the road log begins approximately five miles outside the city limits at the mileage marker on U.S. Highway 66 just west of the overpass at the junction of U.S. Highways 66 and 67.

The City of St. Louis and St. Louis County are endowed with a variety of nonmetallic minerals. Coal has been mined in the past, and at present the county produces limestone, fire clay, sand and gravel, and oil. Cement and brick plants in St. Louis County obtain their raw materials locally. Within the county, the regional northeasterly dip results in exposures of Paleozoic rocks ranging in age from Lower Ordovician to Pennsylvanian.

Missouri is fortunate in having shallow fresh water aquifers throughout most of the Ozark region in the pre-St. Peter sedimentary rocks. One of the main aquifers in this area is the Roubidoux formation which in most cases is shallow enough to permit the construction of low cost wells. However, in the area around St. Louis and St. Louis County the Roubidoux is deep, and the water becomes quite saline. Generally, southwest of a line connecting Chesterfield and Fenton in St. Louis County, water below the St. Peter sandstone will be fresh and potable, but northeast of this line most of the water will be mineralized and unsuitable for domestic use.

St. Louis for many years had the deepest wells in the United States. The Belcher Well at Main and O'Fallon Streets, started in 1849 and completed in 1854, reached a depth of 2199 feet. It antidates the first deep wells of the Pennsylvania oil fields and was the deepest well in the United States up to that time. The St. Louis Insane Asylum well, completed in 1869 (depth 3843 feet), when drilled held the record depth in the country. Both of these wells encountered highly mineralized waters. Granite is reached at a depth of approximately 3800 feet in St. Louis.

The Florissant Oil Field (McCracken, 1955) in north St. Louis County produces from the geographical area of mineralized water. Although some fresh water is found in Mississippian rocks east of this area, oil stains have been noted in the drill cuttings.

Laclede Gas Company, in their search for an underground gas storage site, drilled into the Kimmswick limestone of Middle Ordovician age and discovered the Florissant Oil Field. Since then, Laclede has drilled into the St. Peter sandstone which now serves as underground storage for gas for the St. Louis area.

U.S. Highway 66 on which we will travel to St. Clair is the principal highway between Chicago and the southwest. As it cuts through the Ozarks between St. Louis and Springfield, Missouri, the highway follows approximately the route of a stage line established by the United States Government two decades before the Civil War. During the war, the road was an important military thoroughfare, traveled by both Federal and Confederate troops. The Federal Government at that time put in a telegraph line along the road connecting St. Louis and Springfield; thus, the route was known as the Old Wire Road.

Mileage

0.0 Mileage marker.

This marker is just west of the overpass south of Kirkwood, Missouri, at the junction of U. S. Highways 66 and 67. Busses will travel west (toward Springfield) on U. S. Highway 66.

0.5 Pennsylvanian shale on left.

0.6 St. Louis limestone on right.

0.8 Spergen? limestone in abandoned quarry on left.

This exposure was formerly considered to be part of the St. Louis formation (Hinchey, 1947, p. 52).

1.5 STOP 1 - (35 minutes) - A. C. Spreng and J. W. Koenig.

The Warsaw limestone is exposed in the road cut on the south side of the highway (Fig. 3). A portion of the Keokuk limestone is partially exposed beneath the bridge. Because of the accessibility, abundance, and excellent preservation of the fossils at this locality, the opportunity was taken to attach the following faunal list (Table I).

1.6 Bridge, Meramec River.

2.9 Weiss Airport on left and right.

4.6 Keokuk-Burlington (cherty) limestone in road cut.

An oolitic limestone similar in position and lithology to the Short Creek oolite of southwestern Missouri is exposed in the cut on the right. Unanimous agreement as to whether the oolite in this cut is upper Keokuk or basal Warsaw has not been reached.

Buder Park well is located one mile south of this road cut.

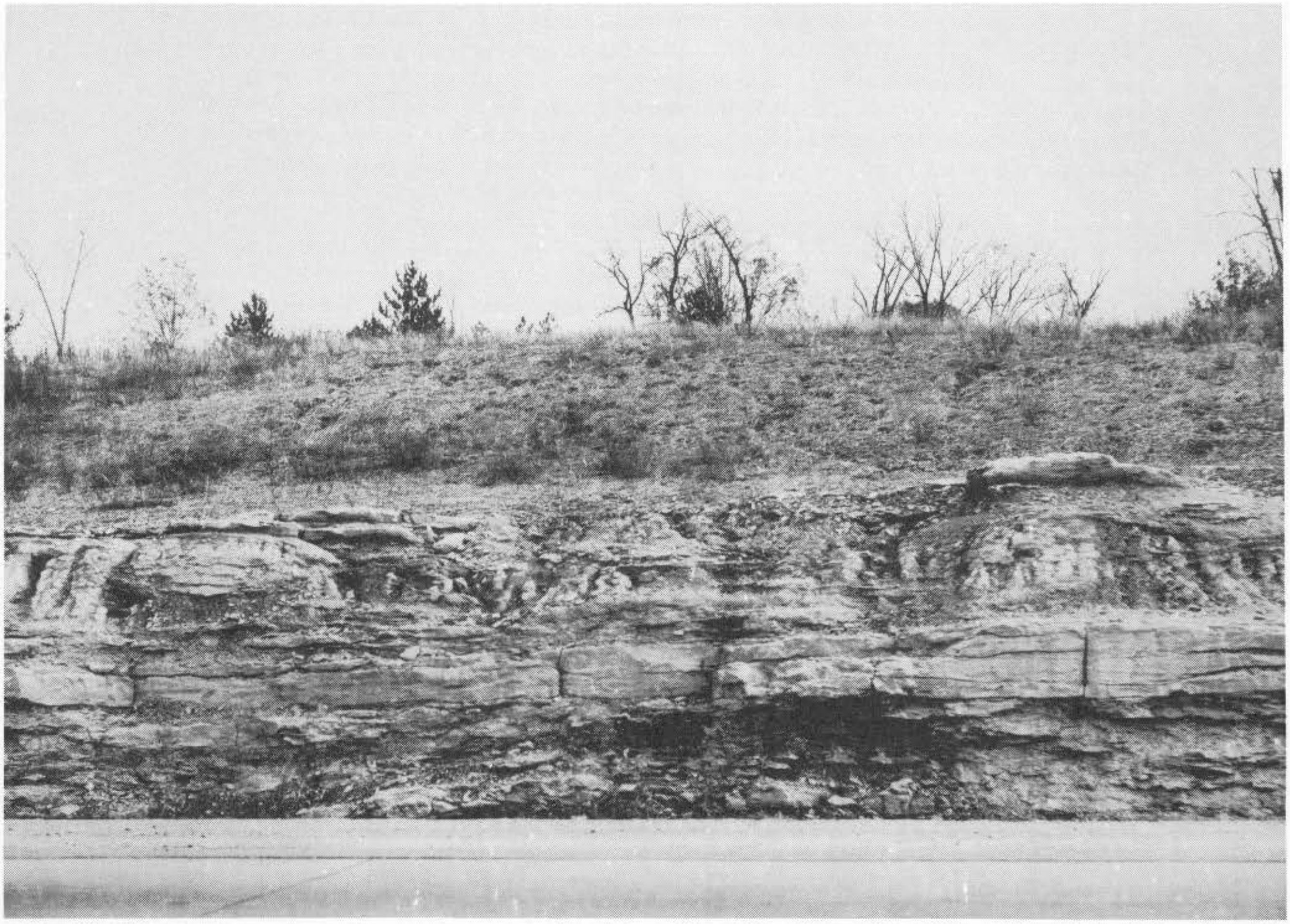


Fig. 3 - STOP 1
Warsaw limestone exposed in road cut on south side of U. S. Highway 66 at Sylvan Beach. NE NW NW sec. 23, T. 44 N., R. 5 E., St. Louis County, Missouri.

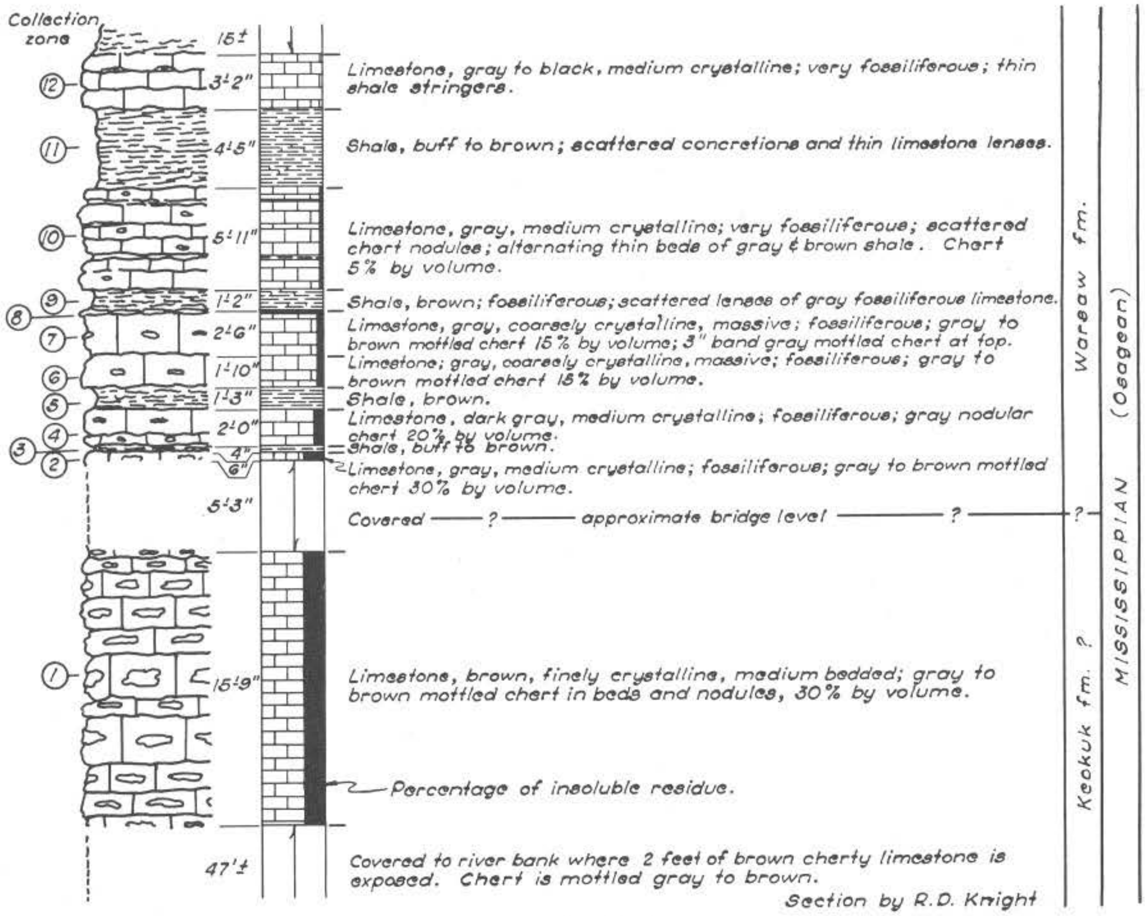


Fig. 4 - STOP 1
Sylvan Beach, NE NW NW sec. 23, T. 44 N., R. 5 E. Kirkwood Quadrangle, St. Louis County, Missouri

Buder Park - Well #1

NW NW SW, sec. 20, T. 44 N., R. 5 E., St. Louis County

Elevation: 545 feet — Logged by R. D. Knight

No samples	0-10
Mississippian System	
Osagean Series	
Keokuk-Burlington limestone	10-205
Fern Glen limestone	205-260
Kinderhookian Series	
Chouteau limestone	260-275
Ordovician System	
Upper	
Maquoketa shale	275-295
Middle	
Kimmswick limestone	295-390
Decorah shale	390-415
Plattin limestone	415-570
Rock Levee-Joachim dolomite	570-615
Total depth	615

5.1 Junction, U. S. Highway 66 and Missouri Highway 141.

Valley park is one mile to the right, and the type section of the Fern Glen formation (basal Osagean) is two miles to the northwest at Fern Glen Station on the Missouri Pacific Railroad.

Busses head west on U.S. Highway 66.

5.6 Bridge, Williams Creek. Three lane highway begins.

8.8 Entrance to Weldon Springs Ordnance Plant on right.

The Ordnance Plant well is located at this entrance.

Weldon Springs Ordnance Plant - Well #4

NE NE NE, sec. 34, T. 44 N., R. 4 E., St. Louis County

Elevation: 665 feet — Logged by John Grohskopf

No samples	0-25
Mississippian System	
Osagean Series	
Fern Glen limestone	25-80
Kinderhookian Series	
Bushberg sandstone	80-100
Ordovician System	
Upper	
Maquoketa shale	100-110
Middle	
Kimmswick limestone	110-200
Decorah Shale	200-230
Plattin limestone	230-370
Joachim dolomite	370-405
Total depth	405

TABLE I

Faunal List, Warsaw limestone, Sylvan Beach

NE NW NW sec. 23, T. 44 N., R. 5 E., St. Louis County, Missouri

(1) Identifications by Alfred C. Spreng
(2) Identifications by John W. Koenig

Brachiopoda (1)

- Athyris lamellosa (L'Eveille). 5
- Athyris sp.. 5
- Brachythyris suborbicularis (Hall) . . . 5,11
- Camarotoechia mutata (Hall) 5,9,10,11
- Cleiothyridina hirsuta (Hall) 5,9
- Cleiothyridina obmaxima (McChesney) 10,11
- Cleiothyridina sp. 9
- Composita sp.. 5
- Delthyris sp.. 5,9
- Eumetria sp.. 5,9
- Productus sp. 5
- Rhipidomella dubia (Hall) 13
- Spirifer tenuicostatus Hall. 5,11
- Spiriferina spinosa? (Norwood & Pratten) 9,10
- Spiriferina aff. transversa (McChesney). .10
- Spiriferina sp.. 5,9,10
- Strophalosia fortispinosa Hinchey and Ray.5
- Torynifera cf. pseudolineata (Hall) 5,9,10,11
- Pseudosyrinx sp. 10

Bryozoa (2)

- Acanthoclema? 9
- Archimedes americanus Condra & Elias . . 5
- Archimedes grandis Ulrich 5
- Archimedes negligens Ulrich. 5
- Archimedes owenanus Hall 5
- Archimedes wortheni Hall. 5
- Bactropora simplex Ulrich 5,9,11
- Batostomella cf. interstincta Ulrich . . . 5,9
- Cyclopora fungia Prout. 10,11
- Dichotrypa elegans Ulrich. 5,9,10
- Dichotrypa intermedia Ulrich. 5,9
- Fenestella compressa Ulrich. 5,9
- Fenestella exigua Ulrich. 5,9,11
- Fenestella rarinodosa Condra & Elias . . . 5
- Fenestella rudis Ulrich. 5,9
- Fenestella serratula Ulrich 5,11
- Fenestella tenax Ulrich. 5,9,10,11
- Fenestella sp. undet. 3,5,10
- Fenestralia sancti-ludovici var. compacta Ulrich. 9
- Glyptopora elegans (Prout) 5
- Glyptopora plumosa (Prout). 5,11
- Glyptopora sp. 9
- Hemitrypa perstriata Ulrich 9
- Hemitrypa proutana Ulrich 3,5,10,11
- Hemitrypa proutana var. nodulosa Ulrich. 9
- Hemitrypa proutana var. vermifera Ulrich 5,9
- Lioclema gracillimum Ulrich . . . 5,9,10,11
- Lioclema punctatum (Hall) 9
- Lioclema cf. punctatum (Hall) 5
- Lioclema punctatum? (Hall) commensal with Aulopora sp.. 10
- Meekopora sp.. 5
- Penniretepora conferta (Ulrich) 5,9
- Penniretepora cf. flexicarinata (Young & Young) 9
- Pinniretepora flexuosa (Ulrich). 9
- Penniretepora vinei (Ulrich). 5,9
- Penniretepora youngi (Ulrich). 3,5,9
- Penniretepora sp.. 10
- Polypora? gracilis Prout. 9,11
- Polypora radialis Ulrich 5,9
- Polypora retrorsa Ulrich. 5,10
- Polypora simulatrix Ulrich 9
- Polypora spininodata Ulrich. 9
- Polypora sp.. 10
- Ptylopora valida (Ulrich). 5,9
- Rhombopora angustata Ulrich. 9
- Rhombopora? asperula Ulrich 9
- Rhombopora attenuata Ulrich . . 3,5,9,10,11
- Rhombopora dichotoma Ulrich 9
- Rhombopora incrassata Ulrich 5
- Rhombopora cf. tabulata Ulrich. 5
- Rhombopora sp.. 9
- Stenopora americana Ulrich. 3
- Stenopora emaciata Ulrich. 5,9,11
- Stenopora montifera Ulrich 5,9
- Stenopora sp.. 5
- Streblotrypa major Ulrich 5,9
- Streblotrypa radialis Ulrich. 10,11
- Sulcoretepora americana (Ulrich) 9,10
- Sulcoretepora nitida (Ulrich) 3,5,9,10
- Sulcoretepora ocellata (Ulrich). . . . 5,10,11
- Sulcoretepora pustulosa (Ulrich). . . . 5,9,11
- Taeniodictya ramulosa Ulrich. 5
- Thamniscus divaricans Ulrich 5,9
- Thamniscus cf. ramalosus Ulrich. 5
- Thamniscus sculptilis Ulrich. 10
- Thamniscus sp. 10
- Worthenopora spatulata (Prout). 9
- Worthenopora spinosa Ulrich 5,9,11
- Worthenopora sp. undet. 3

Coelenterata (1)

- Aulopora?. 9,10
- Cladochonus beecheri (Grabau). 9,11
- Triplophyllites centralis Edwards & Haime 10
- Triplophyllites dalei Edwards & Haime . . 5
- Triplophyllites sp. 5

Echinodermata (1)

- Agaricocrinus wortheni Hall. 5
- Macrocrinus fucundus (Miller & Gurley). . 5

Mollusca (1)

- Platyceras cf. squitaleralis (Hall). 5
- Platyceras (Orthonychia) cf. obliquus (Keyes) 5
- Platyceras sp.. 5

9.0 Contact of Kinderhookian and Osagean Series on right.

At this locality, the Bushberg sandstone and Chouteau limestone (Kinderhookian) underlie the Fern Glen limestone (Osagean) as shown in Figure 5. The Chouteau limestone is so identified on the basis of silicified "worm casts" in the insoluble residues. These forms are diagnostic of the Compton limestone in southwestern Missouri (Grohskopf and McCracken, 1949, p. 23).

You are now entering the Ozarks as defined by the Missouri Geological Survey. You have been traveling on Mississippian or younger rocks, but from now until near the end of the trip you will be on Cambrian or Ordovician strata.

There is no general agreement concerning the boundaries of the Ozarks, but the Missouri Geological Survey considers the area as being bounded on the north by the north bluffs of the Missouri River valley and on the east by a line extending from St. Charles, Missouri, southeast into Illinois. This eastern margin follows the hills adjacent to the Mississippi River. At a location approximately east of Cape Girardeau, the boundary returns to Missouri. It then swings southwesterly along the bluff line through Poplar Bluff into Arkansas.

The Ozarks are characterized by pre-Devonian rocks, relatively high local relief, and by the carbonate rocks being predominantly dolomites rather than limestones. The Ozarks are further distinguished by their many solutional features such as sinks (Bretz, 1950), caves (Bretz, 1956), and large springs (Beckman and Hinchey, 1944) of which there are eleven of first magnitude - a first magnitude spring has an average flow exceeding 64,600,000 gallons per day.

It should be emphasized that the Ozarks cannot be defined as being a large area, all of which is higher than the remainder of Missouri. It is true that the porphyry knob, Taum Sauk Mountain, in Iron County is the highest known point in the state with an elevation of 1772 feet above sea level. Large areas in the Ozarks are at an elevation of over 1400 feet, but there are also appreciable areas less than 1000 feet above sea level, while outside of the Ozarks significant areas at elevations exceeding 1200 feet are not at all unusual.

Although the Ozarks are not necessarily higher than the remainder of the state, they do have greater local contrasts in elevation. For example, the vertical distance between an Ozark stream and the adjacent uplands may be as much as 400 feet, or in the igneous knob area, as great as 800 feet. Outside of the Ozarks, local contrasts in altitude seldom exceed 200 feet except along the Missouri and Mississippi rivers.

9.8 Plattin limestone on right.

10.0 Blue Grass Spring, 300 yards on right.
This spring flows from the base of a Middle Ordovician ledge. The flow,

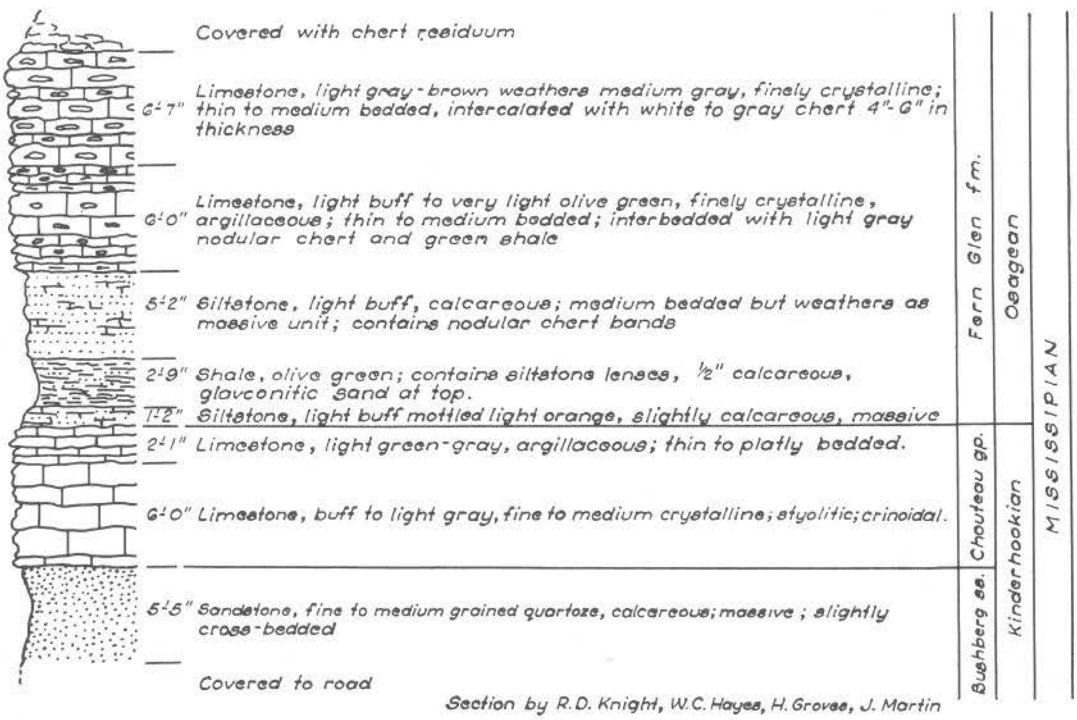


Fig. 5
Weldon Springs Ordnance Plant, NE NE sec. 34, T. 44 N., R. 4 E. Manchester Quadrangle, St. Louis County, Missouri.

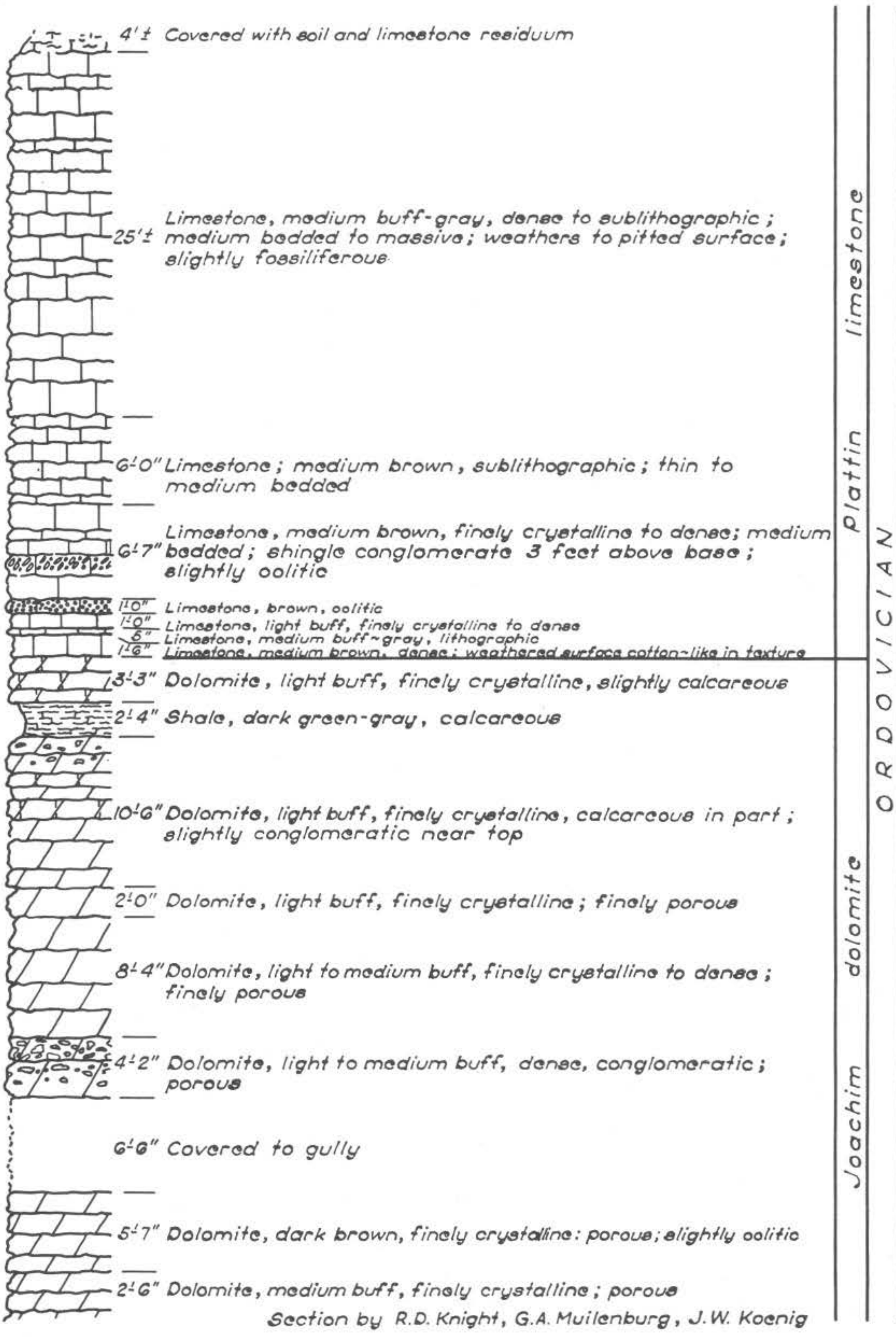


Fig. 6 - STOP 2
Steiny's Inn, NE SW SW sec. 33, T. 44 N., R. 4 E.
Manchester Quadrangle, St. Louis County, Missouri

which has a measured maximum of 776,000 gallons per day (Beckman and Hinchey, 1944, p. 63), passes under the highway.

10.8 Joachim dolomite on right. Four lane highway begins.

11.1 Plattin limestone in road cut.

11.2 STOP 2 - (45 minutes) - Kenneth G. Brill, Jr.

Outcrops in road cuts on both east and west bound lanes are Middle Ordovician. The Joachim-Plattin contact is near the top of the cut on the north side of the east bound lane. Revised formational boundaries within the Middle Ordovician have been proposed by Grohskopf (1948) and Larson (1951). See Fig. 7.

11.4 Bridge, Meramec River.

Joachim dolomite on right, opposite Steinys' Inn (formerly Bridgehead Inn). The water well for Steinys' Inn (W. D. Crowell, Well #2) is located just east of the bridge.

Lower		
Powell?-Cotter dolomite	160-540	
Jefferson City dolomite	540-690	
Roubidoux sandstone	690-820	
Upper Gasconade dolomite	820-855	
Lower Gasconade dolomite	855-1055	
Gunter sandstone member	1055-1075	
Cambrian System		
Upper		
Eminence dolomite	1075-1110	
Total depth	1110	

11.5 Times Beach.

12.6 Overpass, Frisco Railroad.

For much of the next five miles the highway follows the stream valley of Flat Creek. The stream valley is abnormally large relative to the present-day drainage. This anomaly is the result of domestic piracy by the Meramec River which captured Fox Creek seven miles upstream from its former mouth (Fig. 8). This particular capture has been studied in detail by Franklin B. Hanley of Washington University (Hanley, 1924).

<table>
<tr><th>Ulrich,'04,'39</th><th>Weller-St.Clair,'28</th><th>Grohskopf,'48</th><th colspan="2">Larson,'51</th></tr>
<tr><td>Kimmswick</td><td>Kimmswick</td><td>Kimmswick</td><td colspan="2">Kimmswick</td></tr>
<tr><td rowspan="4">Plattin</td><td>Decorah</td><td>"Decorah"</td><td colspan="2">Decorah</td></tr>
<tr><td rowspan="3">Plattin</td><td rowspan="4">Plattin</td><td rowspan="4">Plattin group</td><td>Macy</td></tr>
<tr><td>Hager</td></tr>
<tr><td>Beckett</td></tr>
<tr><td>Murfreesboro</td><td rowspan="4">Joachim</td><td>Bloomsdale</td></tr>
<tr><td rowspan="3">Joachim</td><td>Rock Levee</td><td colspan="2">Rock Levee</td></tr>
<tr><td>Joachim</td><td colspan="2">Joachim</td></tr>
<tr><td>Dutchtown</td><td colspan="2">Dutchtown</td></tr>
<tr><td>St.Peter</td><td>St.Peter</td><td>St.Peter</td><td colspan="2">St.Peter</td></tr>
</table>

Fig. 7
Development of Middle Ordovician terminology in Missouri. (After Larson, 1951, Fig. 2, p. 2044.)

W. D. Crowell - Well #2

SW NE SE, sec. 32, T. 44 N., R. 4 E., St. Louis County

Elevation: 439 feet Logged by John Grohskopf and Earl McCracken

No samples	0-15
Ordovician System	
Middle	
Joachim dolomite	15-75
St. Peter sandstone	75-160

12.7 Joachim dolomite on right.

12.8 Overpass, Missouri Pacific Railroad.

13.0 Joachim dolomite on left.

13.3 Joachim dolomite on right.

13.5 Underpass, City of Eureka.

Joachim dolomite in cut beneath the bridge. The Eureka High School water well is located at the school just north of the underpass.

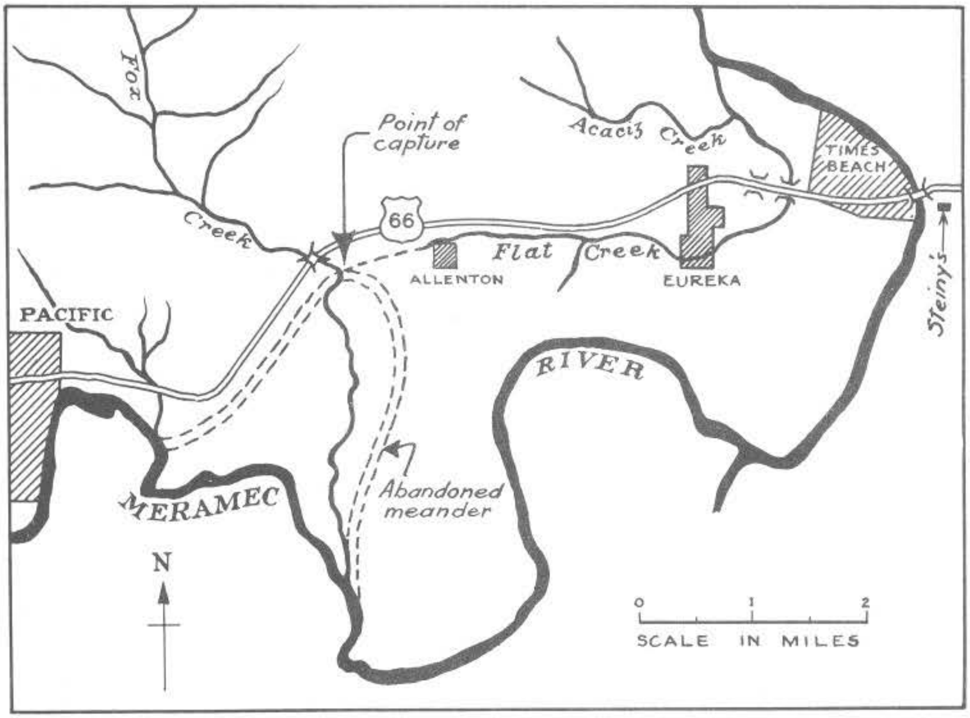


Fig. 8
Map showing relationship of streams involved in the piracy of Flat Creek drainage. (After Hanley, 1924).

Eureka High School - Well #1

NE SE, sec. 36, T. 44 N., R. 3 E.,
St. Louis County

Elevation: 543 feet   Logged by John Grohskopf

Ordovician System	
Middle	
Joachim dolomite	0-88
St. Peter sandstone	88-205
Lower	
Powell-Cotter dolomite	205-325
No samples	325-385
Total depth	385

This well is situated on the east flank of the Eureka anticline which passes west of the town of Eureka and continues through western St. Louis County with a general north-northwest trend. The axial trend of this fold marks the boundary between the area of fresh and mineralized waters from the Roubidoux formation (Gleason, 1935, p. 8).

13.8 St. Peter sandstone on right.

16.3 City of Allenton on left.

From Times Beach to Allenton, drainage in the broad valley has been to the east. From Allenton west for the next 0.8 miles, the drainage has been reversed by the piracy. The following log records the stratigraphy in an Allenton water well.

Rae H. Brooks - Well #2

NE NW, sec. 4, T. 43 N., R. 3 E.,
St. Louis County

Elevation: 481 feet   Logged by Earl McCracken

No samples	0-15
Ordovician System	
Middle	
Joachim dolomite	15-110
St. Peter sandstone	110-230
Lower	
Powell dolomite	230-315
Cotter dolomite	315-560
Jefferson City dolomite	560-720
Roubidoux sandstone	720-850
Upper Gasconade dolomite	850-885
Lower Gasconade dolomite	885-900
Total depth	900

17.1 Bridge, Fox Creek.

An abandoned meander loop of the Meramec River lies on the left of the highway as shown by the dashed lines in Fig. 8.

17.2 Plattin limestone in road cut. Decorah limestone float at top.

17.9 Quarry on right.

Joachim dolomite and Plattin limestone exposed.

18.8 Pacific Sand and Gravel Company on left.

Sand and gravel is dredged from a meander loop of the Meramec River at this locality.

19.5 St. Peter sandstone capped by Joachim dolomite on right.

Bluffs straight ahead show a good contact of St. Peter sandstone and Joachim dolomite.

19.7 Pioneer Silica Products Company on right.

This company quarries the St. Peter sandstone and ships it to Alton and Granite City, Illinois, for glass making, ceramics, scouring-powders, and other silica products.

19.8 Entering Pacific.

Before 1859, the town of Pacific was a small railroad community known as Franklin which marked the western terminus of the Pacific Railroad (Missouri Pacific). Pacific was incorporated as a town in 1859 and is now the junction of the Missouri Pacific Railroad which heads northwest to Kansas City and the Frisco Railroad which heads southwest to Springfield, Missouri, and Texas. Silica mines, tunnelling into the St. Peter sandstone bluffs, furnish employment for many of the town residents.

20.3 STOP 3 - (20 minutes) - Garrett A Muilenburg.

The Joachim—St. Peter contact is slightly above the elevation of the telephone poles. The green, sandy shale is at the contact. The most comprehensive study of the St. Peter was by Dake (1921).

20.8 St. Peter sandstone on right.

21.0 Intersection; four way stop.

23.3 Jefferson City dolomite in road cut.

24.1 George's Orchard on left.

George's Orchard - Well #2

SW NE, sec. 9, T. 43 N., R. 2 E., Franklin County

Elevation: 560 feet — Logged by Lewis Martin

Ordovician System	
Lower	
Cotter dolomite	0-270
Jefferson City dolomite	270-450
Roubidoux sandstone	450-565
Upper Gasconade dolomite	565-615
Lower Gasconade dolomite	615-765
Gunter sandstone member	765-805
Cambrian System	
Upper	
Eminence dolomite	805-905
Total depth	905

24.5 Overpass, Missouri Pacific Railroad.

Cotter dolomite in railroad cut beneath overpass.

25.4 Junction, U.S. Highway 66 and Missouri Highway 100.

Shaws Garden Experimental Farm and Arboretum on left. Evergreen trees from all parts of the world and a great variety of orchids are grown here. The orchid collection is second only to the Kew Gardens of London.

26.6 Cotter dolomite on right.

Both surface and subsurface geologists must rely heavily on insoluble residues in identifying sedimentary rocks of the Ozarks. Diagnostic charts, either in place or as natural occurring "insoluble residues" of thick residuum are invaluable aids in field mapping. Dolomites from various formations are frustrating in their similarity, and in some areas they are concealed by residual cherts more than a hundred feet thick. Accurate subsurface work and ground-water studies would be impossible without preparation of residues from well cuttings. The techniques of identifying and zoning sedimentary rock by this method are described by McQueen (1931), Grohskopf and McCracken (1949), and McCracken (1952 and 1955).

27.6 Diamonds Restaurant on right.

Junction, U.S. Highway 66 and Missouri Highway 100. Busses bear left (southwest) on U.S. Highway 66.

29.6 Jefferson City dolomite on left.

30.2 Jefferson City dolomite in stream cut on right.

31.5 Bridge, Bourbeuse River.

31.7 Junction, U.S Highway 66 and U.S. Highway 50.

Busses continue southwest on U.S. Highway 66.

32.3 Jefferson City dolomite on right.

32.5 Jefferson City dolomite in road cut.

32.7 Jefferson City dolomite in road cut.

33.3 Basal Jefferson City dolomite in road cut.

33.6 Basal Jefferson City dolomite on right.

33.8 STOP 4 - (20 minutes) - Earl McCracken.

The Roubidoux sandstone has been exposed in this area by erosion of a northwest-trending anticline. In addition to being an important aquifer, the Roubidoux formation is a popular source of stone veneer. The paleontology and stratigraphy of this formation are discussed in detail by Heller (1954).

34.2 Roubidoux sandstone and Jefferson City dolomite in road cut.

From here to St. Clair the outcropping rocks are Jefferson City dolomite. Roubidoux sandstone is exposed in the deeper valleys.

38.9 Underpass, Jefferson City dolomite in cut beneath bridge.

The busses make two right turns to go south over the bridge into St. Clair on Missouri Highway 47.

St. Clair has the red-brick stores and rambling frame residences typical of rural trading centers. The town, when settled in 1843, was known as Traveler's Repose until citizens tired of its being mistaken for a pioneer cemetery or a wayside tavern. The name was changed to St. Clair in 1859 in honor of a resident engineer of the Southwestern Branch Railroad.

39.6 Stop. Busses turn right on Missouri Highway 47.

The road log from here to Washington State Park has been modified from the 1954 Guidebook of the Seventeenth Regional Field Conference of the Kansas Geological Society, by Garrett A Muilenburg and Thomas R. Beveridge.

40.8 Junction, Missouri Highways 47 and 30.

Busses turn left on Missouri Highways 47 and 30 and head southeast over the Frisco Railroad viaduct. The following log is from a water well in St. Clair.

City of St. Clair - Well #2

NE NW, sec. 36, T. 42 N., R. 1 W., Franklin County

Elevation: 697 feet   Logged by Earl McCracken

No samples	0-10
Ordovician System	
Lower	
Roubidoux sandstone	10-45
Gasconade dolomite	45-310
Gunter sandstone member	310-340
Cambrian System	
Upper	
Eminence dolomite	340-595
Potosi dolomite	595-675
Derby-Doerun formation	675-830
Davis formation	830-1035
Bonneterre dolomite	1035-1355
Lamotte sandstone	1355-1540
Total depth	1540

A mineral test drill hole, a few miles west of St. Clair, shows limestone instead of dolomite in the Bonneterre formation.

American Zinc, Lead, and Smelting Company - Well #M-1

SW NW SW, sec. 32, T. 42 N., R. 1 W., Franklin County

Elevation: 778 feet   Logged by Earl McCracken

Residuum	0-65
Ordovician System	
Lower	
Gasconade dolomite	65-215
Gunter sandstone member	215-235
Cambrian System	
Upper	
Eminence dolomite	235-445
Potosi dolomite	445-665
Derby-Doerun formation	665-795
Davis formation	795-1015
Bonneterre (limestone)	1015-1272
Total Depth	1272

42.2 Junction of Missouri Highways 47 and 30 with Supplementary Road K.

42.9 Roubidoux sandstone on left.

43.1 Gasconade chert and cryptozoon reef on left.

The contact between the Roubidoux sandstone and Gasconade dolomite is not exposed.

44.1 Gasconade dolomite on left.

45.1 Bridge, Meramec River.

Gravel production on left is from river terraces.

45.9 Cryptozoon reef in Gasconade dolomite on right.

47.3 Junction, Missouri Highways 30 and 47.

Busses turn right (south) on Missouri Highway 47.

47.9 Jefferson City dolomite on left at curve.

55.8 Roubidoux sandstone and Gasconade cryptozoon chert in residuum.

56.8 Junction, Missouri Highway 47 and Supplementary Road FF.

Entering Washington County. From here to STOP 5 we cross over an outcrop area of Gasconade and Eminence dolomites into an area of Potosi outcrops. No exposures are visible.

59.8 STOP 5 - (30 minutes) - Garrett A Muilenburg.

Barite diggings in Potosi dolomite. SW SW, sec. 28, T. 40 N., R. 2 E., Washington County.

Barite was mined in this area for many years. Originally it was worked by hand, each man digging a small circular shaft to bedrock. After reaching bedrock, it was customary to enlarge the shaft laterally from the bottom upward, so that it became jug-shaped. In that way, part of the dirt could be left in the bottom of the hole, avoiding much hoisting, and when the digging finally reached back to the surface the hole was practically filled. Barite recovered during the digging was placed in piles and allowed to dry. When dry, most of the clay could be knocked off, and the clean barite was then ready to be hauled to the loading sheds in DeSoto or Potosi.

In the Ozark region of Missouri, barite occurs throughout almost the entire geologic section from the Cambrian to the Pennsylvanian, but the large commercial concentrations are restricted to a few favored horizons. Strata containing barite are chiefly the dolomite formations of the Upper Cambrian and Lower Ordovician. The principal producing formations in Washington County are the Potosi and Eminence. Of less importance are the Gasconade and Bonneterre. Occurrences are known in the Davis, Derby-Doerun, and Roubidoux. Practically all production comes from residual surface deposits derived from the weathering and erosion of the Potosi and Eminence dolomite. The most productive areas roughly straddle the contact of the two formations, indicating that the upper beds of the Potosi and the lower beds of the Eminence were favorable horizons for mineralization. No commercially valuable vein or bedrock deposits are known. Field relationships indicate that deposition took place in whatever rock formation was at the surface when mineralization occurred. This relationship to surface features is evident throughout the producing area, and seems to imply that mineralization processes were closely related to the physiographic development of the region.

The residuum consists of red clay, chert fragments and boulders, quartz druse, and barite in large and small masses, together with more or less limonite. It ranges from less than a foot to more than 40 feet in thickness. In some places, a foot or more of the upper part consists of fine soil, free of chert, barite or other coarse material, suggesting an eolian origin. Where it is thick, it is stripped off and discarded as mining operations progress. Not all of the residuum contains enough barite to be of commercial value. Lean areas are interspersed among the richer areas, and in places pinnacles of rock project up from the bedrock surface into the residuum.

Before 1936, nearly all of the barite was produced by hand labor. Individuals customarily obtained permission from the land owners to dig on the land, and they paid a royalty of 50 cents per ton. Beginning in about 1937, mechanized mining with power shovels and log washers and other necessary equipment for beneficiation became the accepted practice, and by 1945 mechanization was nearly 100 percent complete.

The minimum of recoverable barite for profitable operation is generally considered to be about five percent of the residuum or 150 pounds per cubic yard of dirt. Large areas of land now being worked were formerly worked over by the hand miners, but they rarely recovered more than 25 percent of the contained barite and left behind all of the fine material and small fragments. With present methods, the yield is around 3,000 tons per acre. The production of crude barite in 1955 was in excess of 350,000 tons, valued at more than $4,000,000. Barite occurrences and mining in Missouri have been recently summarized by Muilenburg (1954).

The village of Richwoods, to the right, was so named because of the rich deposits of lead and barite in the vicinity which were worked even before 1840. It has been estimated that the output of lead from two furnaces at Richwoods was in the neighborhood of 500 tons annually during the period 1845 to 1854.

The following is a summary of a deep well at the Baroid Sales Division, National Lead Company's washer about one-half mile north of here.

National Lead Company - Well #1

NE NW, sec. 27, T. 40 N., R. 2 E., Washington County

Elevation: 750 feet — Logged by R. G. Watson

No samples	0-20
Cambrian System	
Upper	
Potosi dolomite	20-170
Derby-Doerun formation	170-345
Davis formation	345-475
Bonneterre (limestone)	475-835
Lamotte sandstone	835-915
Total depth	915

60.0 Junction, Missouri Highway 47 and Supplementary Road H.

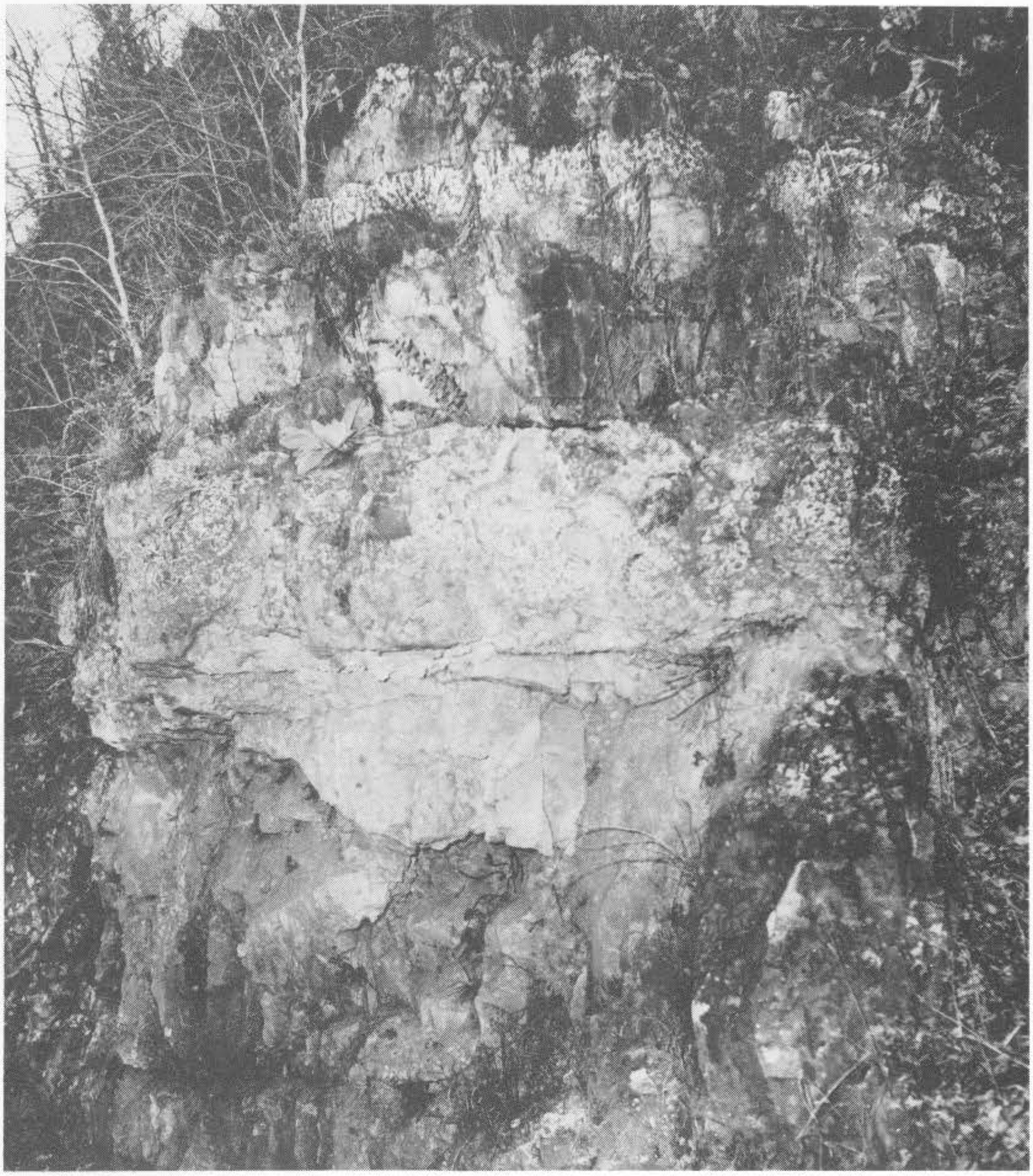


Fig. 9
General view of Potosi dolomite exposed at south end of Mineral Fork Creek Bridge on Missouri Highway 47. SW SE NW sec. 19, T. 39 N., R. 3 E., Washington County, Missouri.

66.6 The bluff ahead is Potosi dolomite, capped by Eminence dolomite.

66.8 Bridge, Mineral Fork Creek.

Approximately 150 feet of Potosi dolomite with abundant quartz druse is exposed in the bluff at the south end of bridge. The upper part of the bluff, characterized by a more gentle slope, is Eminence dolomite.

68.7 Bridge, Old Mines Creek.

68.8 Junction, Missouri Highways 47 and 21.

Busses turn left (east) on Missouri Highway 21. Good exposure of Potosi dolomite with more or less columnar drusy quartz on right. Both Potosi and Eminence dolomite crop out at intervals for the next two and one-half miles. Contacts are uncertain because of faulting. Barite diggings, both old and new, on left and right.

71.3 Golden Pheasant Inn on right.

Entrance to Washington State Park on left. Busses turn left into the park.

Washington State Park consists of 694 acres of wooded hills and ravines along the south bank of Big River. It provides recreational facilities for the public and also serves as a wild life refuge. Almost all species of fauna and flora common to the Ozarks can be found here. The Civilian Conservation Corps was instrumental in improving this area and was largely responsible for building the roads, the lodge, and the museum. Within the Park are well preserved Indian carvings or "petroglyphs" carved in Derby-Doerun dolomite.

Washington State Park. C.C.C. Camp - Well #1

SW SW, sec. 22, T. 39 N., R. 3 E., Washington County

Elevation: 872 feet — Logged by C. D. Gleason

No samples	0-65
Cambrian System	
Upper	
Potosi dolomite	65-130
Derby-Doerun formation	130-230
Davis formation	230-375
Bonneterre (limestone)	375-770
Lamotte sandstone	770-775
Total depth	775

72.7 Derby-Doerun dolomite on right.

The contact of the Potosi dolomite and the underlying Derby-Doerun formation is hidden under the residual soil. The road crosses the outcrop of the Derby-Doerun formation which has a thickness of about 130 feet.

73.1 Davis formation on right includes a bed of "edgewise" conglomerate.

73.4 Entrance to parking area. LUNCH (60 minutes).

73.5 STOP 6 - (30 minutes) - Ernest L. Ohle.

Davis formation (Fig. 11) on left of road above parking area. This locality is within walking distance of the lodge and will be visited immediately after lunch.

73.8 Small fault zone in Davis formation on left.

73.9 Potosi residuum on left is characteristically red in color.

74.5 Derby-Doerun formation in road cut all the way to park exit (Fig. 12).

74.7 Junction of park road with Missouri Highway 21.

Busses turn left (east) on Missouri Highway 21.

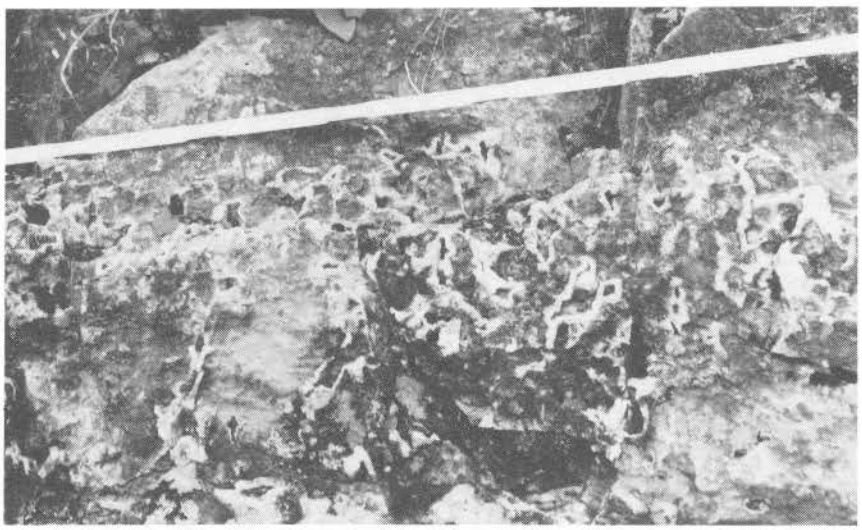


Fig. 10
Detail of Potosi dolomite showing characteristic druse. Exposure at south end of Mineral Fork Creek Bridge on Missouri Highway 47. SW SE NW sec. 19, T. 39 N., R. 3 E., Washington County, Missouri.

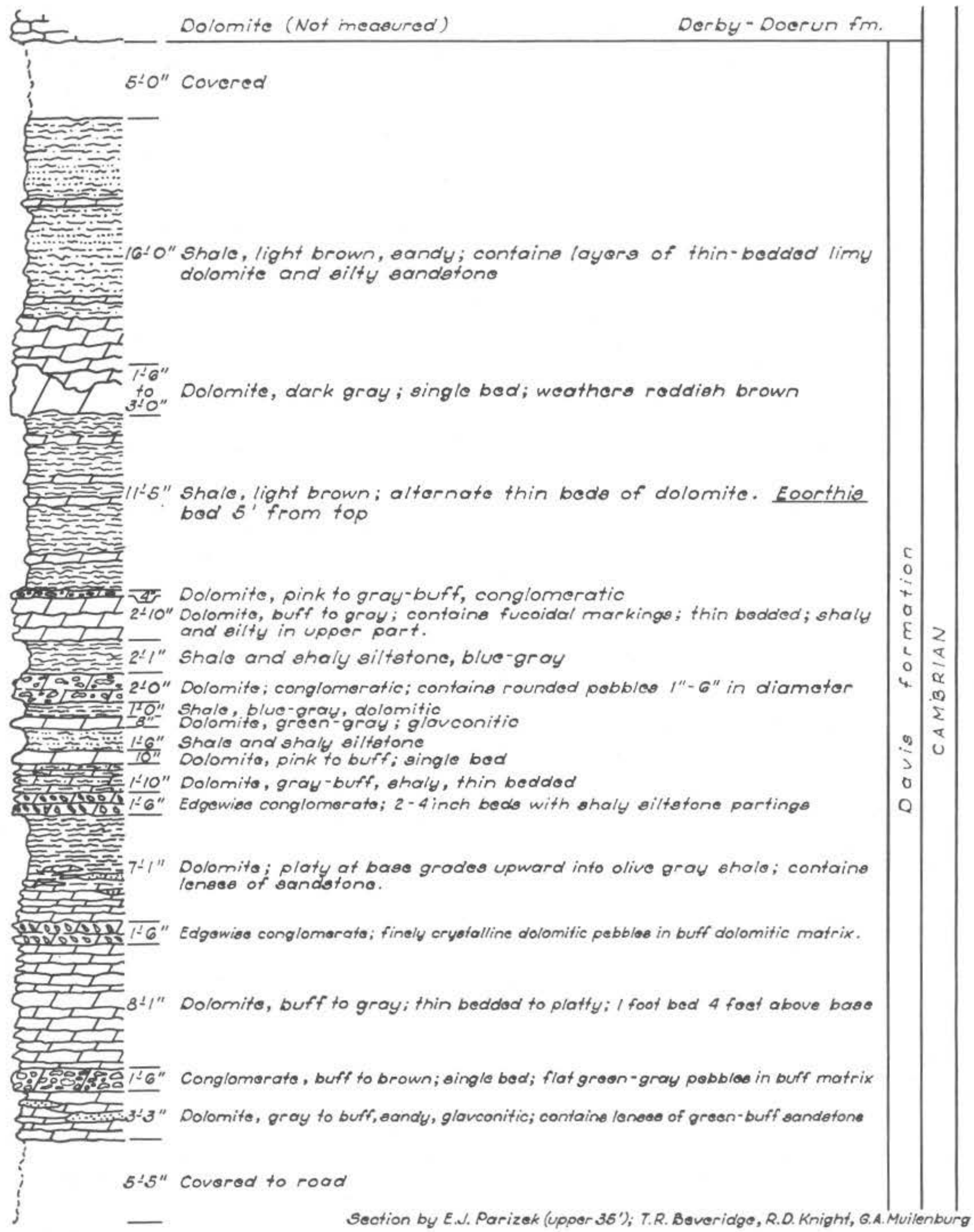


Fig. 11 - STOP 6
Washington State Park, E NW NE sec. 27, T. 39 N., R. 3 E.
Tiff Quadrangle, Washington County, Missouri

75.4 Bridge, Big River. Entering Jefferson County.

75.7 Red soil, residual Potosi, on left.

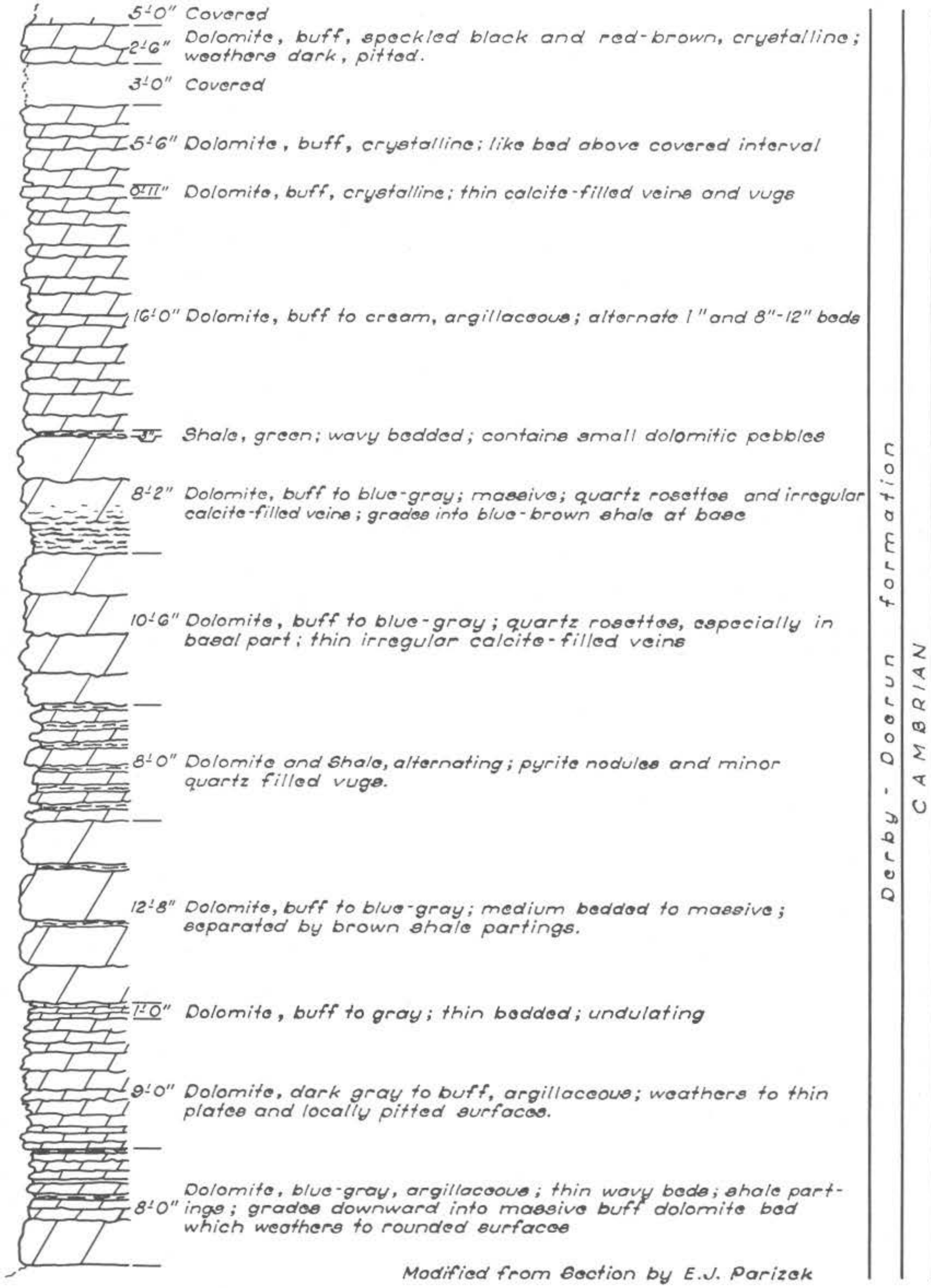


Fig. 12
East entrance, Washington State Park, E NW sec. 26, T. 39 N., R. 3 E.
Tiff Quadrangle, Washington County, Missouri

78.5 Crossing Vineland fault zone.

Eminence, Gasconade, Roubidoux, and Jefferson City formations downthrown on northeast.

78.6 Jefferson City dolomite in road cut.

From here to Hillsboro, all outcrops are of Jefferson City dolomite.

Fig. 13 - STOP 7
Jefferson City dolomite exposed in road cut on Missouri Highway 21 southwest of DeSoto. NW NE sec. 9, T. 39 N., R. 4 E., Jefferson County, Missouri.

81.2 STOP 7 - (25 minutes) - Earl McCracken.

The section of Jefferson City dolomite at this point has 2 feet of "cotton rock"* at the base on the edge of the highway. This grades upward into 2½ feet of brown to buff, mottled, crystalline dolomite. Above is 10 feet of "cotton rock" with calcite-filled vugs and small quartz rosettes. A 2-inch layer of white, dead appearing chert separates 5 feet of brown to gray, mottled dolomite containing large calcite filled vugs, from the "cotton rock" below. Above this is soil and residual chert.

This section is estimated to be about 140 feet above the Roubidoux sandstone. Beds of more massive, coarsely crystalline dolomite are exposed below the level of the road in nearby valleys. These may be equivalent to the pitted dolomite which is common in the lower part of the formation in numerous other localities. Lithologically, the Jefferson City dolomite is very heterogeneous. Dolomite, argillaceous dolomite, "cotton rock", sandstone, chert, lenses of quartzite, oolite, conglomerate, and shale are found in the formation. A section of the formation in one locality is rarely duplicated by the same succession of beds in another locality, although in a general way there is a recognizable similarity. Although easily recognized "cotton rock" horizons are extremely useful in determining the stratigraphic contacts in some places, they cannot be entirely relied upon in even small areas for similar horizons also occur at different stratigraphic positions within the formation.

*"Cotton rock" is a local term applied to fine-grained argillaceous magnesium limestone.

83.0 Junction, Missouri Highway 21 and Supplementary Roads N and H.

The balance of the road log has been modified from the 1949 Guidebook, Field Conference, Thirty-fourth Annual Convention of the American Association of Petroleum Geologists, by J. V. Howell and others.

83.9 Junction, Missouri Highway 21 and Supplementary Road Y.

85.4 Junction, Missouri Highways 21 and 110.

Busses continue north on Missouri Highway 21.

86.1 Bridge, Cotter Creek.

88.7 Jefferson City dolomite on left.

89.9 Entering Hillsboro. St. Peter sandstone in ditch on right.

City of Hillsboro - Well #1

NW NW NE, sec. 3, T. 40 N., R. 4 E., Jefferson County

Elevation: 807 feet Logged by Earl McCracken

Soil and residual clay	0-30
Ordovician System	
Lower	
Powell dolomite	30-140
Cotter dolomite	140-415
Jefferson City dolomite	415-555
Roubidoux sandstone	555-670
Upper Gasconade dolomite	670-725
Lower Gasconade dolomite	725-880
Gunter sandstone member	880-900
Cambrian System	
Upper	
Eminence dolomite	900-931
Total depth	931

90.2 Junction, Missouri Highway 21 and Supplementary Road BB.

91.1 Junction, Missouri Highway 21 and Supplementary Road A.

91.2 St. Peter sandstone on left.

91.9 Jefferson City dolomite on right.

95.0 Jefferson City dolomite on right.

95.1 Bridge, Sandy Creek.

Note red "covered bridge" on right.

95.2 Jefferson City dolomite in road cut.

95.3 Junction, Missouri Highway 21 and Supplementary Road to Goldman.

96.3 St. Peter sandstone in road ditch on right.

96.6 Joachim dolomite marked by 3 to 4 inch thick chert zone.

96.8 Joachom dolomite-Plattin limestone contact marked by bench on both sides of road.

97.0 Plattin (lithographic) limestone in road cut.

97.2 Plattin (lithographic) limestone in road cut.

Sink on left, on far side of exposure, contains remnants of Mississippian and Pennsylvanian rocks.

97.5 Plattin limestone in road cut.

To the left is a sink with Pennsylvanian shales (red) and a block of the Decorah formation at the top of the road cut.

101.5 Ottoville; junction, Missouri Highway 21 and Supplementary Road M.

St. Paul's Lutheran Church on right.

St. Paul's Lutheran Church - Well #1

NE NE NE, sec. 18, T. 42 N., R. 5 E., Jefferson County

Elevation: 879 feet Logged by R. D. Knight

No samples	0-60
Mississippian System	
Osagean Series	
Fern Glen limestone	60-125
Kinderhookian Series	
Bushberg sandstone	125-150
Ordovician System	
Middle	
Kimmswick limestone	150-200
Decorah shale	200-220
Plattin limestone	220-375
Rock Levee dolomite	375-415
Joachim dolomite	415-520
St. Peter sandstone	520-540
Total depth	540

103.9 Bushberg sandstone on left.

Note cross-bedding in sandstone.

104.1 A log of a well at the residence on the right shows the following section:

W. W. Schytt - Well #1

NW SW, sec. 5, T. 42 N., R. 5 E., Jefferson County

Elevation: 778 feet Logged by John Grohskopf

No samples	0-37.5
Ordovician System	
Middle	
Kimmswick limestone	37.5-50
Decorah shale	50-85
Plattin limestone	85-95
Total depth	95

105.2 STOP 8 - (30 minutes) - Robert D. Knight

St. Johns' Catholic Church and School. Contact of Upper Ordovician and Lower Mississippian at top of bench on far side of parking area (Figs. 14 and 15). The Kimmswick in many areas is an exceptionally pure limestone which is quarried for chemical grade calcium carbonate (Hinchey, 1947).

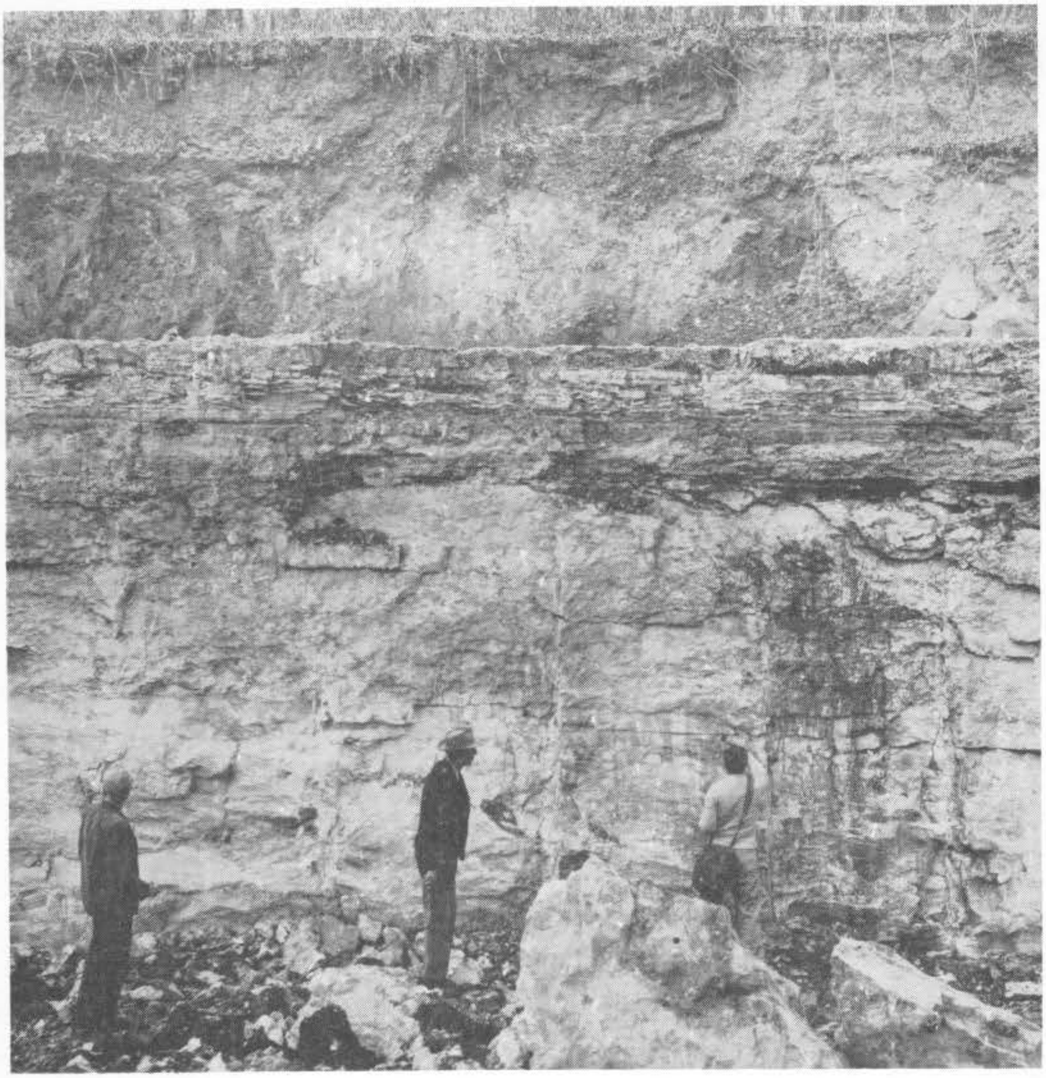


Fig. 14 - STOP 8
Kimmswick limestone, Maquoketa shale, and Bushberg sandstone exposed in excavations for St. John's Catholic Church and School on Missouri Highway 21, approximately one mile south of Rock Creek. SW SW sec. 32, T. 43 N., R. 5 E., Jefferson County, Missouri.

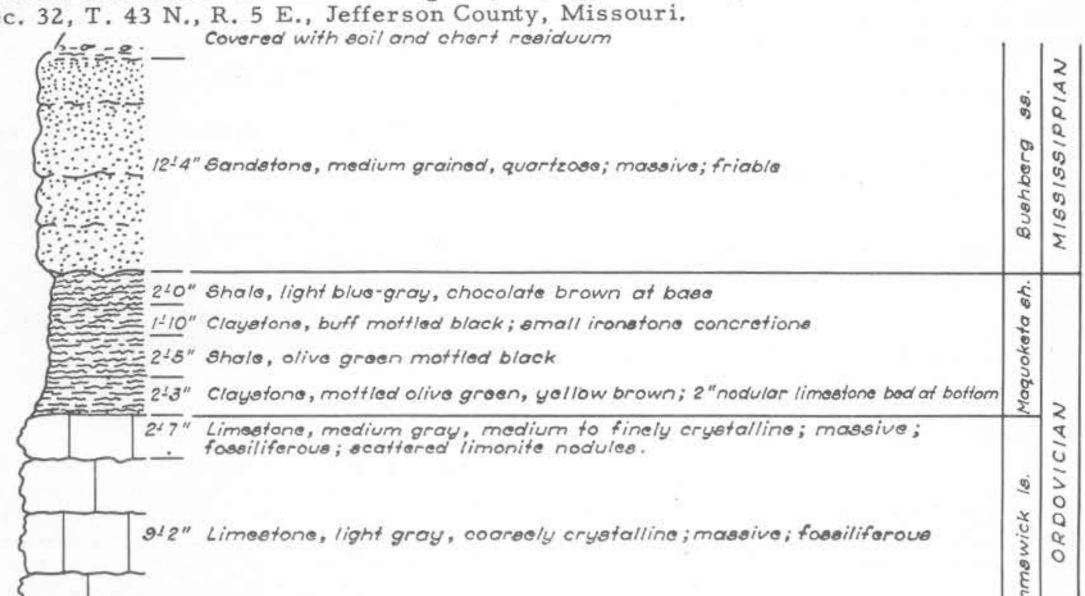


Fig. 15 - STOP 8
St. John's Catholic Church and School. SW SW sec. 32, T. 43 N., R. 5 E.
Kimmswick Quadrangle, Jefferson County, Missouri

St. Johns' Catholic Church and School - Well #1

SW SW, sec. 32, T. 43 N., R. 5 E., Jefferson County

Elevation: ? feet — Logged by R. D. Knight

No samples	0-80
Ordovician System	
Middle	
Decorah shale	80-100
Plattin limestone	100-265
Joachim dolomite	265-395
St. Peter sandstone	395-415
Total depth	415

the Reeds Spring formation in southwest Missouri.

107.3 Burlington-Keokuk limestone in road cut.

109.1 Spergen limestone on right.

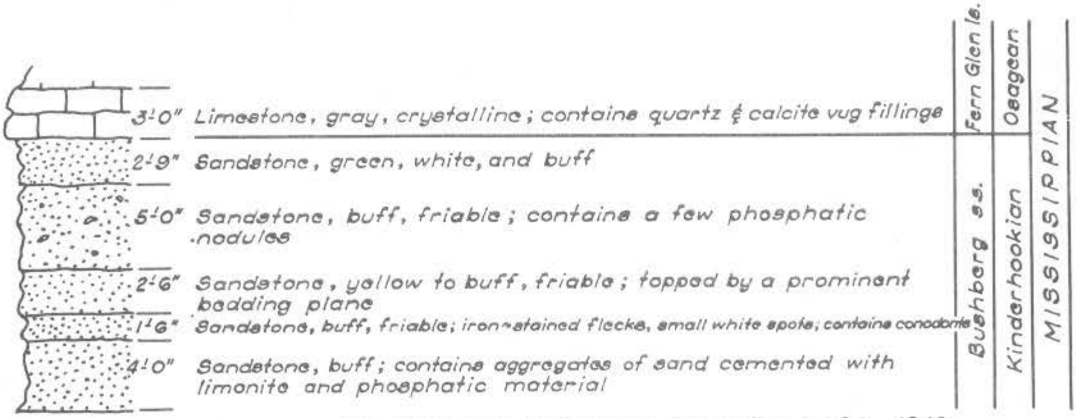
109.8 Spergen limestone on left.

110.2 Warsaw limestone on left.

110.3 Junction, Missouri Highways 21 and 141.

Busses continue northeast on Missouri Highway 21.

110.8 Bridge, Meramec River. Entering St. Louis County.



From Guidebook, 34th Annual Convention A.A.P.G., 1949

Fig. 16
Rock Creek, SE NW SE sec. 28, T. 43 N., R. 5 E.
Kimmswick Quadrangle, Jefferson County, Missouri

106.0 Kimmswick limestone in bluffs on left.

106.1 Bridge, Rock Creek.

106.6 Maquoketa shale on left.

106.8 Kimmswick limestone on left.

106.9 Bushberg sandstone-Fern Glen limestone contact on right (Fig. 16).

107.1 Fern Glen limestone on right.

The alternating thin beds of limestone and chert of this outcrop resemble

111.6 Spergen limestone on left.

112.2 St. Louis limestone on left.

112.7 The valley at this point cuts into Spergen limestone, but the Spergen-St. Louis contact is not exposed along the highway.

113.0 St. Louis limestone at top of hill on left.

116.7 Junction of Missouri Highway 21 with U. S. Highways 61 and 67.

Loess covered hills on both sides.

END OF TRIP

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